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ARTICLE 34 AMENDMENTS

FIG. 21 is a plan view of a two-resonance antenna of a third embodiment according to the present invention.

FIG. 22 is a view illustrating a VSWR characteristic of the two-resonance antenna according to the third embodiment of the present invention.

5 FIG. 23A is a view illustrating a radiating characteristic of the two-resonance antenna according to the third embodiment of the present invention.

FIG. 23B is a view illustrating a rotative direction of the two-resonance antenna according to the third embodiment in FIG. 19A.

10 FIG. 24 is a plan view of a two-resonance antenna according to a fourth embodiment of the present invention.

Best Mode for Carrying Out the Invention

Hereinafter, with reference to FIGS. 4 to 24, first to fourth embodiments according to antenna of the present invention are described.

15 (First Embodiment)

FIG. 4 is a plan view of a two-resonance antenna 1. In the present embodiment, a major axis and a minor axis of a base member 3 are assigned to an X-axis and a Y-axis, respectively, and the X-axis and Y-axis perpendicularly cross each other.

20 The two-resonance antenna 1 is an antenna formed in a film shape and comprises a base member 3, a ground conductor 5, a first antenna element 7 and a second antenna element 9. The base member 3 is formed of a rectangular thin plate with flexibility and is made of dielectric material such as resin of a polyamide system. The ground conductor 5, the first antenna element 7 and the second antenna element 9 are formed on a surface of the base member 3. The ground conductor 5, the first
25 antenna element 7 and the second antenna element 9 take the forms of conductors each which is formed in a thin film shape and is made of metal such as beaten-copper.

First resonance of the two-resonance antenna 1 is generated by electric current distributed on the first antenna element 7. Namely, this resonance is generated by an inverted-F antenna formed of the first antenna element 7. A resonance principle of the inverted-F antenna is the same as that of a $\lambda/4$ monopole antenna. A length of the first antenna element 7 is about one fourth of a radio wavelength. Impedance matching which causes the inverted-F antenna to generate the resonant frequency is carried out by changing a connecting position of the center conductor 13 of the coaxial cable 11.

Second resonance of the two-resonance antenna 1 is generated by electric current distributed on the second antenna element 9. Namely, this resonance is generated by a deformed dipole antenna formed of the second antenna element 9. A resonance principle of the deformed dipole antenna is the same as that of a $\lambda/2$ dipole antenna. If alternating-current electricity is supplied from the center conductor 13 of the coaxial cable 11 to the first antenna element 7, first electric current flows on the second antenna element 9 because the first antenna element 7 is capacitively coupled with the second antenna element 9. The first electric current is distributed on the second antenna element 9. Second electric current flows on the outer conductor 17 because the second antenna element 9 is capacitively coupled with the outer conductor 17. The second electric current flows to a GND surface of the ground conductor 5 through the second connecting portion 5B. A length of the second antenna element 9 is about one second of a radio wavelength. Impedance matching which causes the deformed dipole antenna to generate the resonant frequency is carried out by changing a thickness of the sheath 18 intervening between the second antenna element

9 and the outer conductor 17. Therefore, in the deformed dipole antenna, it is important not to electrically contact the second antenna element 9 to the outer conductor 17 by means of the insulation layer such as the sheath 18.

The two-resonance antenna 1 has a VSWR characteristic shown in FIG. 6 and a radiating characteristic shown in FIG. 7A.

The VSWR (Voltage Standing Wave Ratio) is described below in detail. In a state of connecting an electric power supply line to the antenna, when alternating-current electricity flows in the electric power supply line, electric current flows on the antenna. Voltage vibration generated on the electric power supply line by the electric current is termed a progressive wave. If there is a difference between a characteristic impedance of the electric power supply line and a characteristic impedance of the antenna, electric current is reflected at a point where the electric power supply line is connected to the antenna, which causes some of the electric current to return to a transmission side. Voltage vibration generated on the electric power supply line by the returned electric current is termed a reflected wave. In general, if there is the reflected wave on the electric power supply line, an electric power loss occurs at the point where the electric power supply line is connected to the antenna. Therefore, the characteristic impedance of the electric power supply line and the characteristic impedance of the antenna are mutually adjusted so as to have the same values to suppress a generation of reflected wave as less as possible. If there are the progressive wave and the reflected wave on the electric power supply line, two waves are synthesized to form a standing wave. A ratio between the maximum amplitude and the minimum amplitude of the standing wave is termed VSWR. The VSWR and a power loss rate (reflected power) R are respectively defined by Eqs. (2) and (3) by using a reflection coefficient $|\Gamma|$ defined by Eq. (1).

portion 39. Longitudinal axes of the upper end portion 35 and the lower end portion 39 extend along the X-axis, and lateral axes of these components extend along the Y-axis. A distal end 35A of the upper end portion 35 is located on a -X side with respect to a distal end 39A of the lower end portion 39. A longitudinal axis of the interconnecting portion 37 extends along the Z-axis, and a lateral axis of this component extends along the Y-axis. One end of the interconnecting portion 37 is connected to a base end portion 35B of the upper end portion 35, and the other end of the interconnecting portion 37 is connected to a base end portion 39B of the lower end portion 39.

A length of the base member 3 is set to equal a total length of the upper end portion 35, the interconnecting portion 37 and the lower end portion 39 of the support member 33. The base member 3 and the support member 33 are fixed to each other by means of a two-sided tape or adhesive. In a state of fixing the base member 3 to the support member 33, the base member 3 is disposed on an outside surface of the support member 33. The ground conductor 5, the first antenna element 7 and the second antenna element 9 are foldable depending on a folded status of the base member 3. Also, the base member 3 may be provided with rigidity and used as a support in place of the support member 33.

The two-resonance antenna device 31 has advantageous features listed below.

Even if displacement occurs in a relative position between the support member 33 and the base member 3 at a time of applying the base member 3 on the support member 33, no changes occurs in the shape of the ground conductor 5, the shape of the first antenna element 7, the shape of the second antenna element 9, the relative position between the ground conductor 5 and the second antenna element 9 and the relative position between the first antenna element 7 and the second antenna element 9.

embodiment, a major axis and a minor axis of a base member 43 are assigned to an X-axis and a Y-axis, respectively, and the X-axis and the Y-axis perpendicularly cross each other.

The two-resonance antenna 41 is an antenna formed in a film shape and comprises the base member 43, a first antenna element 45, a second antenna element 47 and an impedance adjustment element 49. The base member 43 is formed of a rectangular thin plate with flexibility and is made of dielectric material such as resin of polyamide system. The first antenna element 45, the second antenna element 47 and the impedance adjustment element 49 are formed on a surface of the base member 43.

The first antenna element 45 is a conductor formed in a strip shape with a first radiating portion 45A, a second radiating portion 45B and an interconnecting portion 45C. The first radiating portion 45A is disposed along the X-axis. The second radiating portion 45B is disposed on a +Y side with respect to the first radiating portion 45A and along the X-axis. A distal end 45G of the second radiating portion 45B terminates on a +X side with respect to a distal end 45F of the first radiating portion 45A. The interconnecting portion 45C is disposed along the Y-axis and provides electrical connection between a base end 45E of the first radiating portion 45A and a base end portion 45D of the second radiating portion 45B. With such an arrangement, a slit portion 46 having an open at one end thereof is formed on the base member 43.

The second antenna element 47 is formed in a strip shape. The second antenna element 47 is disposed in the slit portion 46 along the X-axis. A distal end 47A of the second antenna element 47 terminates on a +X side with respect to the distal end 45F of the first radiating portion 45A and on a -X side with respect to the distal end 45G of the second radiating portion 45B.

a second rear surface antenna element (91) formed of a thin-film and strip shaped conductor, disposed in the rear surface slit portion and electrically connected to the second antenna element (47, 87).

5 33. The antenna according to claim 32, wherein

the first rear surface antenna element (89) comprises:

a first rear surface radiating portion formed in a slip-shape;

a second rear surface radiating portion formed in a slip-shape and disposed in parallel to the first rear surface radiating portion; and

10 a rear surface interconnecting portion connecting one end of the first rear surface radiating portion and one end of the second rear surface radiating portion, and

the second rear surface antenna element (91) is disposed between the first rear surface radiating portion and the second rear surface radiating portion and in parallel
15 to the first rear surface radiating portion.

34. (New) The antenna according to claim 1, further comprising:

a support member (33) having rigidity and fixedly securing the base member (3).

20 35. (New) The antenna according to claim 34, wherein the base member (3) is integrally formed with the support member (33).

36. (New) The antenna according to claim 5, wherein set positions of the first
25 connecting portion (7C), the second connecting portion (5B) and the contact portion (9A) are independently arranged one another.

37. (New) The antenna according to claim 16, further comprising:

a support member (33) having rigidity and fixedly securing the base member (3).

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38. (New) The antenna according to claim 37, wherein the base member (3) is integrally formed with the support member (33).

39. (New) The antenna according to claim 21, wherein set positions of the first connecting portion (51), the second connecting portion (55), the first contact portion (53) and the second contact portion (57) are independently arranged one another.

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